

New Training Content and Production Support in the S1000D Technical Data Specification, ver4

Wayne Gafford
Advanced Distributed Learning Co-Lab
Alexandria, Virginia
Wayne.Gafford@adlnet.gov

Paul Haslam
O'Neil & Associates
Ft. Worth, Texas
phaslam@oneil.com

Jeff Clem
Lockheed Martin
Moorestown, New Jersey
jeffrey.d.clem@lmco.com

Stefano Tedeschi
Isselnord
La Spezia, Italy
stefano.tedeschi@isselnord.it

Carla Kieckhefer
L-3 Communications / D.P. Associates Inc
Arlington, Virginia
Carla.Kieckhefer@L-3com.com

Thomas Malloy
BAE Systems
Glasgow, Scotland
thomas.malloy@baesystems.com

Dr. Leslie Lucas
Submarine Learning Center
Groton, Connecticut
leslie.lucas@navy.mil

ABSTRACT

The international S1000D technical data standards community has recognized the requirement to support DoD training content. During 2007, the S1000D training subcommittee developed key and fundamental proposals to support technical data and training content integration for the newest edition of S1000D. This presentation will detail how S1000D version 4 supports training, including new learning-oriented information models, a SCORM-oriented aggregation model using native S1000D processing, instructional design codes for use in S1000D-based filenames, and guidelines for preplanning reusable data. The presentation will also present learning content in S1000D and in its SCORM-conformant output. Emphasis will be placed on how the use of S1000D ensures that learning content is in sync with products and systems it supports.

ABOUT THE AUTHORS

Mr. Wayne Gafford combines a background in teaching and education with XML-based standards that has resulted in innovative ideas for e-learning content management and data interoperability. For the last four years, Mr. Gafford has lead subcommittees, studies and prototype projects that explore how learning content can benefit from structured markup. Results have lead to an increased awareness that standardized metadata and XML structure can unify diverse but related content that support common systems, procedures and products. Mr. Gafford has taken his research to the Advanced Distributed Learning Initiative where he is the Director of the Job Performance Technology Center. He is a member of the DITA and S1000D learning subcommittees, an active public speaker at S1000D and Advanced Distributed Learning (ADL) events, and a supporter of developing XML schemas that model instructional development and learning content to improve knowledge management and distributed learning.

Mr. Paul Haslam followed up a maintainer career in the Royal Air Force with the development of the electronic documentation parts of Defence Standard 00-60 since its inception. He is currently serving on the core S1000D international management team as the S1000D Secretariat and as co-chair on the S1000D training subcommittee. He was responsible for developing S1000D to cover land systems. He is Managing Director of his own company, Ten On Eleven Ltd, specialising in electronic publications.

Mr. Jeffrey Clem is a leader in the research and implementation of human performance technology that enables today's workforce to achieve valued results. With over 10 years researching and designing e-learning solutions, Mr. Clem has helped shape distributed training and performance support systems for US Department of Defence and foreign military clients. He holds a Master of Science degree in Instructional and Performance Technology from Boise State University 's College of Engineering. Mr. Clem is currently employed by Lockheed Martin MS2 as the lead analyst and designer of various simulation and game-based learning solutions for the USN. Jeff lead the development of the newly required <learnCode> in the DMS, an element that captures the instructional design description of the learning content in the DM.

Mr. Stefano Tedeschi is the Information Technology deputy manager at ISSLENORD. His responsibilities include Research and Development. He has been spending his energy searching the best way to integrate SCORM and S1000D. Stefano is the Isselnord point of reference regarding the S1000D standard. He is a member of CALS Italia and he has actively contributed within the NAV70 working group to the definition of the new, S1000D based, NAV70 tech pubs standard. Since 2006 he has been the "Simplicio" project team leader, a product that manages data product life cycles and includes SCORM capabilities. He is currently the program manager of one of the first projects based on a SCORM and S1000D integrated philosophy within the Italian defence market.

Mrs. Kieckhefer has worked for L-3/DPA for 8 years. Her focus is on technical manuals and electronic performance support systems. Currently she works with the Research and Development department to develop tools for writing courseware and technical manuals. She is currently leading the production efforts for a training development tool that produces SCORM and S1000D conformant IMI. She is also working with the S1000D Training Subgroup to develop a Learning Content Aggregation Model for S1000D that integrates SCORM and Learning Object Model requirements.

Leslie Lucas, Ed.D., is the Supervisor of Instructional Systems at the Submarine Learning Center (SLC), Groton, CT. She oversees the SLC Learning Standards Office and is the principal instructional design authority on new curriculum development projects. Dr. Lucas co-authored the Navy Integrated Learning Environment (ILE) Content Developer's Handbook and the Navy ILE Instructional Content Style Guide: Interactive Multimedia Instruction & Instructor-Led Training. Dr. Lucas received a B.A. from Temple University, and an M.S. and Ed.D. in Educational Technology from Lehigh University.

RETHINKING TECHNICAL DATA AS INTEGRATED TECHNICAL INFORMATION

The S1000D training subcommittee is an international collection of technical writers, developers, logisticians and managers generating new standardization concepts for originating, managing, integrating and producing technical information products. The subcommittee's work breaks traditional stove-piped organizational practices that separate training from other technical content practices by regarding each form of system documentation as "technical information." Information ranging from planned maintenance, to testing, to evaluation, to technical manuals, to training, to parts is in essence *configuration items*. Like a part or component that must be managed in a warehouse, technical information must be similarly managed in a database for its intellectual and support value to be an ongoing and readied asset in the lifecycle logistics of machinery and systems. This white paper serves as a progress report from the S1000D training subcommittee.

S1000D Management Groups Endorse Technical Information Harmonization

The United States and the International S1000D management groups endorse and promote the integration of related technical information that document common systems. As of S1000D version 4.0, technical training information will be supported by XML structures, file naming conventions, and configuration metadata.

This white paper covers what the S1000D training subcommittee has contributed to version 4.0 of the specification.

HOW S1000D SUPPORTS TECHNICAL TRAINING INFORMATION

The same XML management and metadata strategies used in the service of traditional technical information production are now applied to the service of technical learning production. The S1000D training subcommittee added three new features to S1000D that support the configuration management of technical learning information: XML-based modeling, learning design codes and learning data module aggregation.

XML-based Learning Information Modeling

In S1000D, a data module is the smallest chunk of information managed in a database. Those chunks of information represent different "types" of information required to document a system. The most general type of data module is the "descript" (description) data module. Its intent is to capture and represent descriptive information. Being the most generic of all S1000D data modules, it contains section, paragraph, step, graphic and table structures. Its model is intentionally generic so it can capture and represent the widest variety of technically descriptive information without excluding any system requiring descriptive documentation. The new data module schema is called "learning.xsd" and delivers a structured openness that does not impede the development and intent of training. **Figure 1** illustrates how the S1000D learning data module structure cascades to the learning content branch.

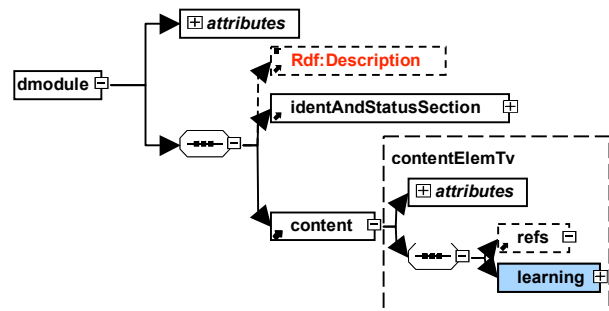


Figure 1 – High Level Illustration of the Learning Content Data Model

The Five-Branch Learning Information Model

The learning information model contains five "branches" that cover S1000D technical learning information. **Figure 2** illustrates the branches as learning plan, learning overview, learning content, learning summary and learning assessment. One branch per data module instance may be used. Therefore, multiple learning data modules must be created to support an entire learning event. The design strategy prevents the introduction of too many new data module types while retaining the flexibility of chunking information into modular topics.

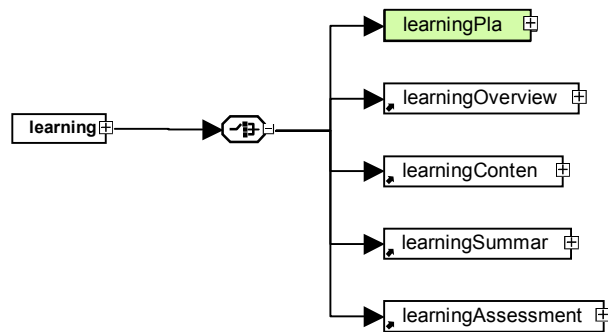


Figure 2: Five learning content branches in an S1000D learning data module

The Learning Plan Branch

The learningPlan branch contains foundational documentation regarding the course design. It includes justification on why training is needed, a description of the target audience, a comparison of job and training requirements, and learning objectives. It also includes technical considerations such as the optimal mix of instructional strategies and instructional delivery techniques to support learning. The learnPlan defines the training program and provides a foundation for subsequent design, development, implementation, evaluation, and maintenance activities. **Figure 3** illustrates five high level planning areas in the model.

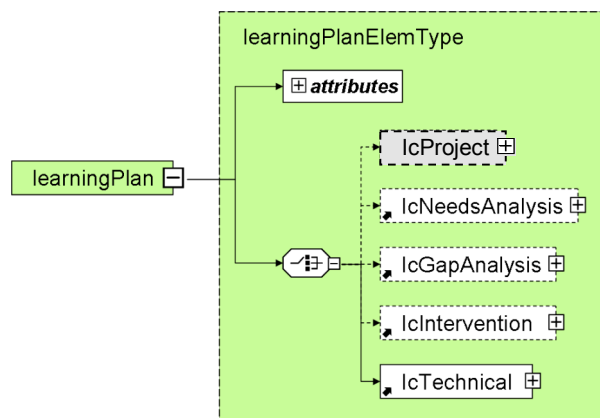


Figure 3: The Learning Plan Model

The Learning Overview Branch

The overview branch is the first content introduced in the learning event. It covers subject matter, prerequisites, learning objectives and sets the

expectations for student performance. However, the learning overview is not required to sit at the front of a lesson. Overview information can be dispersed throughout a course as the occasion for looking ahead to new learning is warranted. **Figure 4** illustrates the learning overview branch of the learning data module.

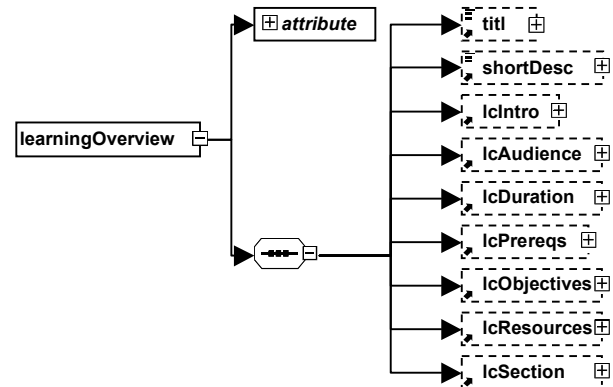


Figure 4: The Learning Overview Branch

The Learning Content Branch

The learning content branch contains the content that supports each learning objective. The content may include instructional and technical information from authoritative sources and provide details that help the learner relate the content to the requirements of a job. It may also include instructional activities and strategies that support the learning process. Figure 5 illustrates the learning content branch.

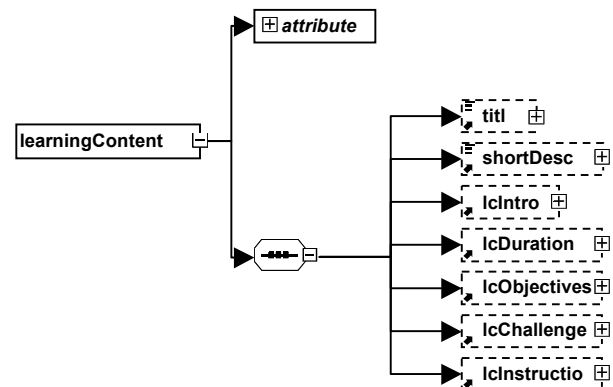


Figure 5: The Learning Content Model

The Learning Summary Branch

The learning summary branch offers opportunities for review and the ability to look ahead at future lessons. It is the bridge from the learning content to the assessment. However, like the overview information, it can be used throughout the lesson as a tool for an in-process review. The summary does not always have to be placed at the physical end of a lesson, as summaries can occur at anytime given the instructional design and the amount of learning content that has accumulated to a particular point. **Figure 6** illustrates the learning summary branch of the learning module.

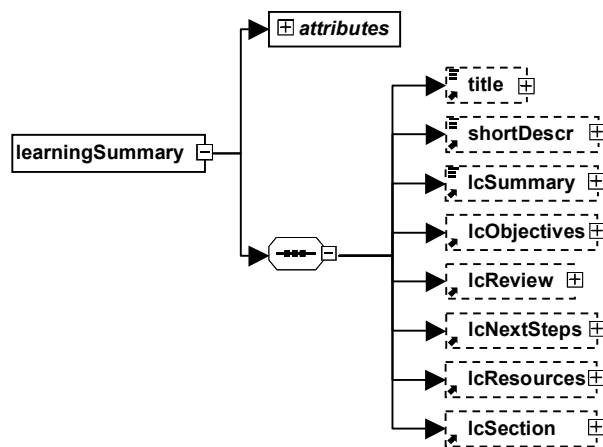


Figure 6 – The Learning Summary Model

The Learning Assessment Branch

Learners need to be regularly assessed on performance during instruction to ensure that they are developing required proficiencies. The learning assessment branch is the critical point in measuring a student's learning performance. Each assessment question is an interaction, which links assessments to learning objectives that help enable the necessary sequencing in SCORM. The learning assessment branch is best used for assessment structured with pre-designed correct answers. It does not support essay questions requiring instructor evaluation. **Figure 7** illustrates the learning assessment branch of the learning module.

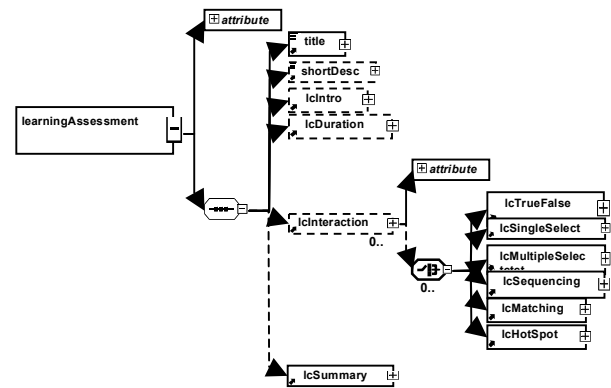


Figure 7 – The Learning Assessment Model

FROM LEARNING INFORMATION MODELS TO LEARNING CODES

The learning information models provide the necessary XML-based structures and configuration metadata to manage technical learning information concurrent with authoritative source materials. The general nature of the S1000D learning information model branches does not identify the *instructional methodology* implicit in the learning content. Identifying the intended instructional design strategy is a significant piece of information that helps build context for identifying learning data modules. The next section describes a considerable expansion to the core of S1000D: the introduction of the “learn code” and “learn code event” into the data module code (DMC).

Learn Codes and Lifecycle Information Management

The learn code provides an unprecedented means for capturing two types of information: human performance technology (HPT) and instructional design information. Prior to the addition of learn codes to the S1000D specification, technical data specifications did not support a standardized way to identify information about training and human performance as part of a file naming convention. Learn code information is placed at the end of a DMC when a data module contains technical learning information. Learn codes ensure that human performance requirements and instructional design intentions stay relevant to technical learning information as systems evolve through lifecycles. It is crucial for a data manager to know how a system design change affects supporting documentation, including human performance requirements and training. S1000D now serves as a common digital

data format for technical learning and human performance information.

Capturing HPT in a DMC

As a systematic approach to analyzing requirements that improve human performance, HPT is a field of practice that encompasses instructional systems design. S1000D 4.0 introduces a set of learn codes specifically for HPT data modules. The coding framework for HPT data modules is derived from an industry-recognized HPT model developed by VanTiem, Moseley and Dessinger and is documented in S1000D. Below is an example of three types of HPT codes documented in S1000D for use in the learn code:

- **H18** = Work Environment Information from Environmental Analysis
- **H31** = Performance Support Requirements
- **H53** = Summative Analysis Data on Job Transfer

As seen in **Figure 9**, an “H” is placed in the first position of the learn code field. The second and third characters in the learn code together indicate a major phase within the HPT model. For example, an “H18” in a learn code signifies that the data module contains technical information resulting from a performance analysis of the end user’s work environment. The data module code then tells a complete story about what information is stored in the learning data module. The story is told through a combination of the learn code (LC), the information code (IC), the standard numbering system (SNS) and the model identification code (MI).

Figure 9 can read: “This data module contains information that describes work environment information from an environmental analysis (LC H18) when ultrasonic cleaning (IC) is performed on the main tank of a hydraulic power unit (SNS) belonging to the EuroFighter (MI).”

This information can then be viewed or exported to other design documents for use by all project team members, from performance system designers to training developers. If project members conduct a work environment analysis during the planning phase of the project, members will discover factors that will affect the use of S1000D information products by end users. Prior to the S1000D 4.0 specification, such information would be saved to a random location, limiting its use by other project team members as

they develop information and training data modules that support the end user. Furthermore, that valuable information would likely be lost over the project’s lifecycle because it would have resided outside of the S1000D database and not catalogued in a standardized manner.

Capturing Training Information in a DMC

The coding framework for capturing training information in a DMC provides a robust and coherent context for creating and identifying a learning data module. The framework is derived from Robert Gagne’s theory of instruction known as the Nine Events of Instruction, and would be recognizable and relevant to instructional designers. Gagne developed the framework while serving in the U.S. Air Force. Other well-established theories of instruction, learning and motivation are reflected in the training learn codes to facilitate their use and understanding across instructional system design (ISD) practitioners. Below is an example of three types of training codes documented in S1000D for use in the LC:

- **2D** = Enabling Learning Objective for Intellectual Skill of the Procedure Type
- **43** = Static Content for Concept Learning
- **57** = Learning Guidance provided as a Demonstration

As seen in **Figure 10**, a “T” is placed in the first position of the LC field. The second character of the LC indicates an event of instruction to which the training data module is mapped. The third character of the LC provides more specificity regarding the kind of content contained in the data module. **Figure 10** can read: “This data module contains information that contains an enabling learning objective that is for a procedural intellectual skill type (LC T2D) used in teaching ultrasonic cleaning (IC) as performed on the main tank of a hydraulic power unit (IC) belonging to the EuroFighter (MI).”

ISD practitioners will be able to easily identify this data module in the S1000D database and know its content and the creator’s intended use for that data module: use of Gagne’s second event of instruction – inform learner of objectives.

Capturing the Learn Event Code in the DMC

The learn event code (LEC) identifies what learning branch is being used in the learning data module. All LCs are used in conjunction with an LEC. The LEC is a single character alpha code for projects that have a requirement to document learning information and is placed in the last DMC position. The coding is as follows:

A = Learning plan
B = Learning overview
C = Learning content
D = Learning summary
E = Learning assessment

Figure 10 also illustrates which branch of the learn schema is being used. For example, an LEC of “C” in a DMC signifies that the data module uses the

learning content data structure contained in the learn schema.

The data structures provided by the learn schema have been designed to recognize the instructional design process in the S1000D specification. These structures have been modeled with course development, course content and course assessment in mind. In addition, the DMC applied as a technical training content filename fills in an ADL Initiative specification gap: ADL does not declare naming conventions in SCORM. SCORM primarily addresses how a content package is constructed so that it operates in any SCORM-conformant LMS. File naming conventions are left to individual learning development teams. S1000D fills the ADL/SCORM file naming gap by providing data module coding structures that configures the learning content to the supported systems and assemblies.

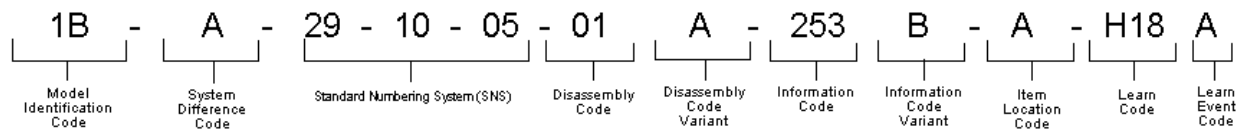


Figure 9 - Sample DMC with HPT Learn Code

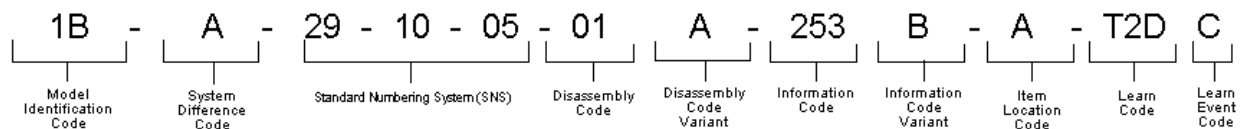


Figure 10: Sample DMC with Training Learn Code and Learn Event Code

FROM LEARNING CODES TO LEARNING DATA MODULE AGGREGATION

Support for learning information in S1000D through information modeling and learn-HPT codes in data module file naming structures are instrumental for content creation, configuration management and lifecycle tracking. S1000D version 4.0 adds one more integral component to support technical training: aggregation.

Aggregating Learning and Technical Information

There are two identifiable issues when bringing training support into S1000D. The first is how to plan for the reuse and repurpose of technical data in e-learning when an originating one-to-one link between the learning content and authoritative technical source information does not formally exist. The second issue is how to aggregate technical data modules and specific training modules during production while taking into account that training data goes beyond what relevant technical data offers.

Typically, learning and maintenance organizations do not plan to share content. Each organization will write its content with different audiences and purposes in mind. Technical data tends to be written in short, terse sentences leaving only the most essential data for the maintainer to perform a task. Training content provides instructionally robust information based on authoritative technical data.

To accommodate planning and content reuse into a learning information product, S1000D introduces the SCORM Content Package Module (SCPM). It supports collecting any type of information required to build a learning product for use in SCORM compliant content packages. The SCPM specializes in configuration and life cycle support of learning content packages.

The S1000D SCORM Content Package Module

SCPM is a derivative of the publication module, which is the original S1000D aggregation function for referencing data modules in the build up of technical manuals. One important difference exists between the aggregation function in a certified SCORM content package and the S1000D aggregation function: the S1000D aggregation function does not contain an application programming interface (API) allowing technical information to be exchanged and tracked by an external application, such as a learning management system (LMS) or an inventory supply system. The SCPM further harmonizes S1000D and SCORM by using SCORM terminology in collecting electronic content during its production phase in a common source database.

How the SCPM Supports the Aggregation and Description of Technical Learning Information

The S1000D `scormContentPackage` represents an aggregation of the complete technical learning deliverable during the content production process prior to the compiling of the content package for SCORM conformance testing.

Like the S1000D data module, the SCPM contains two types of information: metadata and content. The metadata section provides address, status and LOM information for the entire learning package. The content section provides file referencing mechanisms required for aggregation and output. Together, they provide a powerful tool for configuring a SCORM content package directly to a system, component or assembly.

Figure 11 illustrates the high-level structure of the `scormContentPackage`. It contains two element types: “`identAndStatusSection`” (metadata) and “`content`”. The “`identAndStatusSection`” type contains a configuration and package naming section. The “`content`” type contains a “`scoEntry`” section that represents the collection of all referenced assets that will populate a SCO. It references data modules, multimedia, xPath statements and nested SCOs.

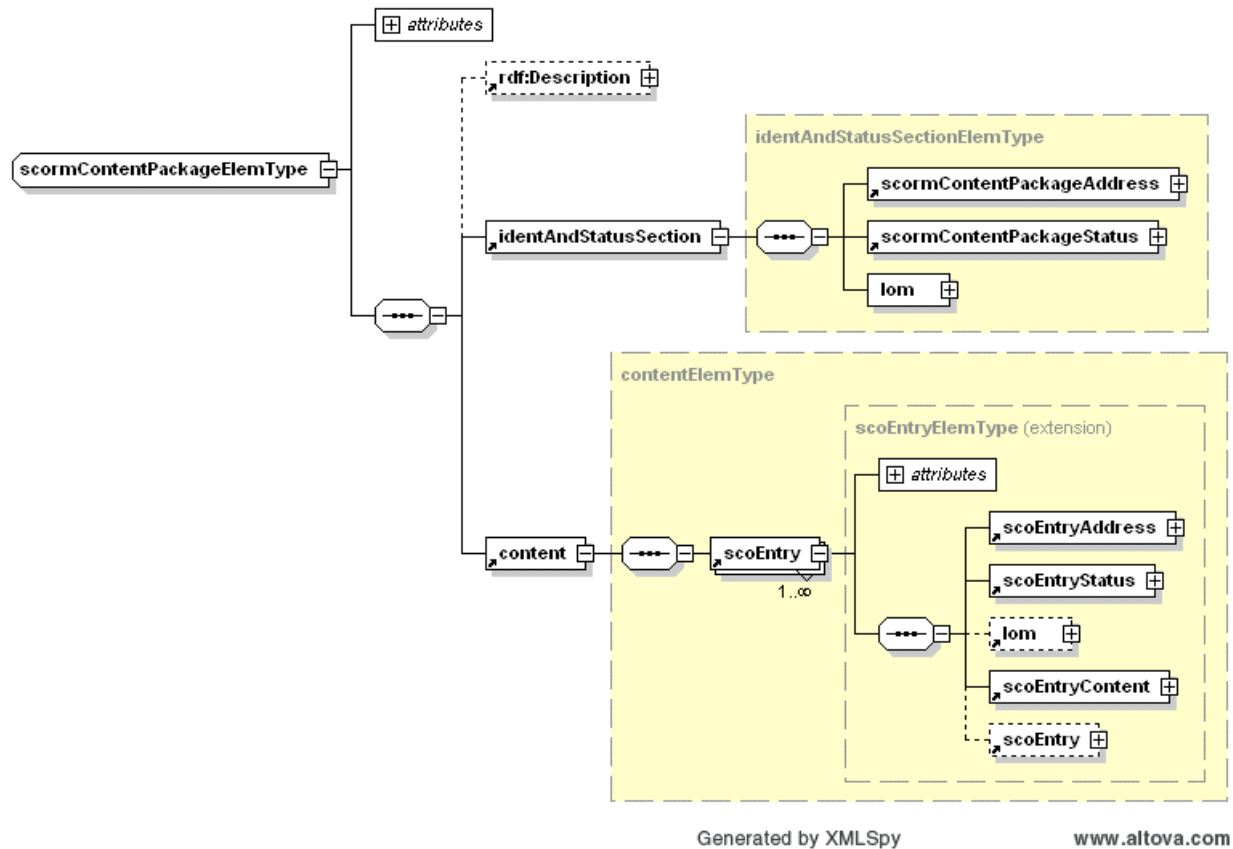


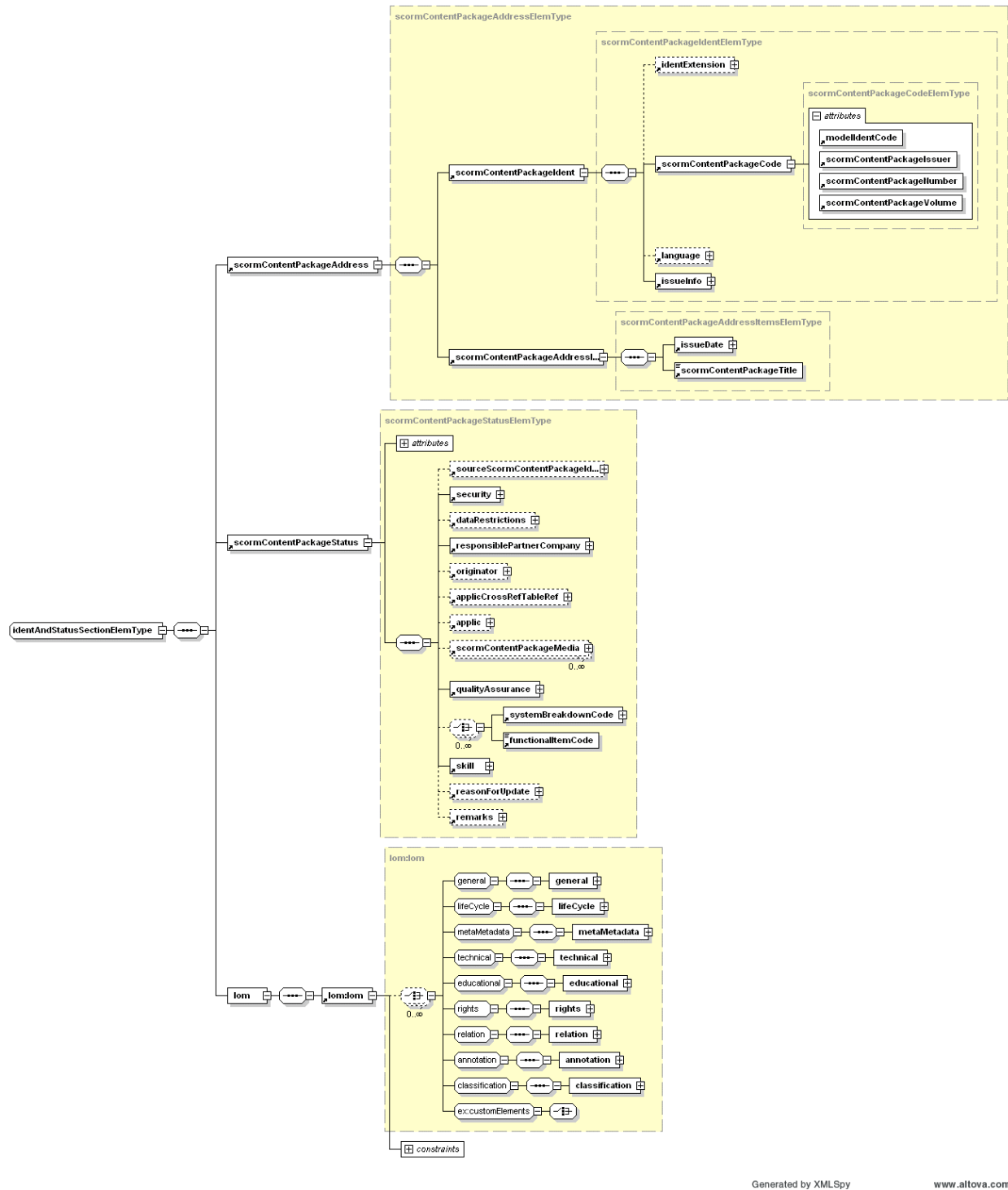
Figure 11: The SCPM Aggregation Model

How the SCPM Supports the Description of Resource Types

The identAndStatus section of the SCPM contains three metadata types: address (naming), status (production and configuration), and learning (IEEE LOM). LOM has been introduced to S1000D version 4.0 aggregation description capabilities. The address and status section have always been used in the publication module. In version 4.0, the terms “scormContentPackage” and “SCO” replace “PM”, or publication module, throughout the aggregation file to harmonize ADL SCORM terminology with S1000D structures and functions.

The identAndStatus Element Type

Figure 12 illustrates how the identAndStatus element type contains a rich and diversified harmonization of scormContentPackage naming, status and metadata. Its purpose is to provide configuration management to the learning product deliverable. The learning product deliverable can be named and associated with the system, component or subcomponent it supports. Naming and configuration of ADL SCORM learning content packages are necessary features for the improvement of content life cycle management processes.



Generated by XMLSpy

www.altova.com

Figure 12 – The SCPM `identAndStatus` Element Type

How the SCPM Supports the Aggregation of Resource Types

The SCPM content section references four resource types: data modules, Xpaths statements, graphics and multi-media, and external SCOs. The four types are contained in the scoEntryContent element type. Like the scormContentPackage element, use of the “SCO acronym” in S1000D signifies the purposeful collection of technical learning information during the content planning and production phase. A “SCO” in S1000D *does not launch digital content or send a request to an LMS*. It maintains a parallel between production and post-production versions of the same content while maintaining associations to identAndStatus metadata.

The scoEntryContent Element Type

Figure 13 illustrates how the scoEntryContent element type references content through the “data module reference” element (dmRef). External SCOs are called by the “externalSCO” element. The dmRef contains the “data module reference identifier” (dmRefIdent) element. It contains references to whole data modules, references to objects within data modules using the “Xpaths” element, and references to illustrations and multimedia using the “extraResources” element. References are categorized.

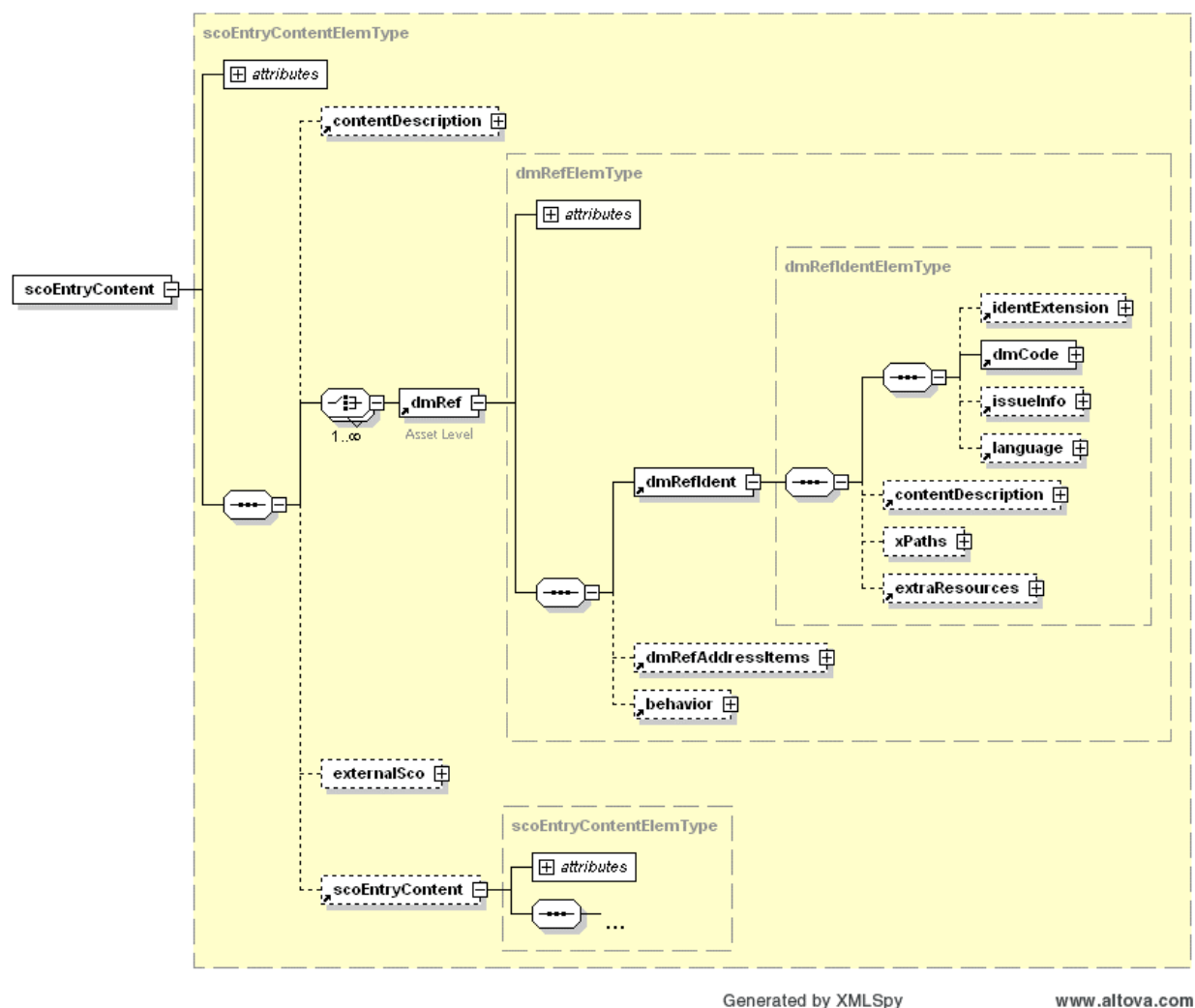


Figure 13 – The SCPM scoEntryContent Element Type

TECHNICAL LEARNING INFORMATION IN THE LIFECYCLE LOGISTICS CONTEXT

Content management efficiencies gained by modeling learning information, identifying content using learn codes and using learning-oriented aggregations would be lost if the timely identification, update and distribution of the learning information were not made concurrent with authoritative sources at the completion of system design changes. S1000D is a lifecycle logistics tool, and it treats technical learning information like a lifecycle element.

Training Information as a Lifecycle Logistics Element

The original incentive to develop technical data and training integration methods stood as a logistics and content distribution problem. Training organizations received updated technical manuals through supply system distribution lists, the same distribution lists populated by typical end users. Training organizations are not typical end users. They are production organizations that develop learning information products based on authoritative sources distributed to supply systems. This business process resulted in the development, delivery and instruction of learning materials one to two years after the installation of a system. The use of S1000D to support technical learning information finally linked engineering change proposals to training in a lifecycle logistics context.

Stove-piped Logistics

Stove-piped logistics have prevented the synchronous and agile identification of all system information that must be reviewed according to an engineering change proposal. Stovepipes and non-standardized data formats have encouraged separate information creation and delivery organizations. Those organizations include:

- engineering
- spares
- technical manuals
- training
- planned maintenance
- testing and evaluation

Using S1000D can help break information stovepipes in lifecycle logistics by identifying metadata common to each organization.

How S1000D Recognizes Training as a Logistics Element

Integrated information that is routinely updated to document system changes must have key metadata in common for an efficient, standards-based content review and change notification system to succeed. The S1000D metadata system breakdown code (SBC), captures the system identification that links all related data modules together and configures them to components they document. For the first time, technical training information can be stored in an XML format expressly designed for lifecycle support and training information management. It is a multi-layered solution that finally allows for rigorous and explicit content management as if it were a part managed in a warehouse.

SUMMARY AND CONCLUSION

S1000D version 4.0 is a technical information specification that harnesses the primary fundamentals of configuration management and applies it to technical learning. That application solves long standing review, update and distribution issues that have plagued learning organizations with content production scheduling out of sync with system design changes and installations.

The configuration methods used by traditional technical data organizations now applied to technical learning will offer new opportunities for content planning, whether that planning is for dual-purpose data and multimedia, or the mapping of task analysis to learning objectives.

The value-added proposition in using S1000D for all technical information to support a common system is a reduction in total ownership costs for content management. It also lays the groundwork for future specifications and interoperability solutions that will combine aspects of SCORM's distribution model with S1000D's data model. The two combined could present a never-before seen specification that unites the controlled content movement and playback with the explicit version and configuration control required to maintain information readiness. S1000D is a lifecycle logistics tool that unites technical organizations with instructional developers through the power of XML.